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ECONOMIC COMMISSION FOR AFRICA

Regional Preparatory Meeting on New and Renewable Sources of Energy

Addis-Ababa, 12-16 January 1981

REPORT OF THE TECHNICAL PANEL OF EXPERTS ON HYDROPOWER

Addis-Ababa, 20-24 October 1980

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INTRODUCTION

Part one

1. In the framework of the preparations for the United Nations Conference on New and Renewable Soruces of Energy to be held in August 1981 at Nairobi, Kenya, the United Nations Economic Commission for Africa (ECA) organized three simultaneous meetings of experts from 20 to 24 October 1980 at Addis Ababa, Ethiopia in the areas of hydropower, geothermal energy and biomass conversion, including fuelwood and charcoal.

The participants were experts from several African countries who had been invited to attend in a personal capacity.

Opening of the Panel (agenda item 1)

2. The meeting was opened on 20 October 1980 by the Deputy Executive Secretary of ECA. In his opening address, he congratulated and welcomed all the participants who had accepted the invitation of ECA. In so doing, they had chosen to make the experience and knowledge they had acquired in the service of their own countries available to the Commission so that it might better understand the constraints currently facing African countries in developing and carrying out an energy policy in line with the hoped and real needs of their people. No region was as aware of the importance of the United Nations Conference on New and Renewable Sources of Energy as was Africa. In the wake of what had come to be called the energy crisis, oil costs of many of the Commission's member States had become increasingly onerous, threatening the very existence of some of them. In addition, at the same time, those countries experienced a steady increase in the cost of goods and services from the industrialized countries, an equally steady decrease in bilateral and multilateral development aid and a serious deterioration in their terms of trade. After recalling that the mandate of the United Nations Conference on New and Renewable Sources of Energy covered 14 forms of energy, the Deputy Executive Secretary stressed that within those different areas Africa had important assets which would, enable it to play a pioneering role in the exploitation, development and utilization of those sources of energy.

In order to do that, however, African countries needed to define a common position at a time when negotiations would be stepped up to define a strategy with respect to the establishment of a new world economic order. Even if the inflexibility of energy structures made it evident that new and renewable sources of energy might not play a significant role in providing African States with energy before the twenty-first century, it was nevertheless clear that the decisions taken before 1985 would decisively influence the extent of their contribution to the improvement of the energy situation in Africa.

Thus those obstacles which might limit the large-scale exploitation of those forms of energy must be identified at once, and appropriate ways and means of overcoming them must be sought. That was the task the Deputy Executive Secretary set for the participants in the work of the Technical Panels of Experts. In conclusion, he wished them every success in their work which would be an important contribution to the success of the Intergovernmental Meeting

on New and Renewable Sources of Energy to be organized by ECA 12 to 16 January 1981 at Addis Ababa, Ethiopia.

Election of officers (agenda item 2)

3. The following officers were unanimously elected to direct the work of the Technical Panel of Experts on Hydropower:

Chairman:	Marcel Niat Director-General of the Societe Nationale d'Electricite du Cameroun
Vice-Chairman:	Roy G. Miti General Manager of Zambia Electricity Supply Corporation
Rapporteur:	Ratsimiebo Majilo, Chief Department des Grands Travaux de la JIRAMA, Madagascar

4. The list of hydropower experts is attached as an annex.

Adoption of the agenda and organization of work (agenda item 3)

5. After discussing the provisional agenda and the draft programme of work submitted by the secretariat for their consideration, the experts adopted the following agenda:

1. Opening of the Panel
2. Election of officers
3. Adoption of the agenda and organization of work
4. Role of hydropower within the context of the energy crisis
5. Situation, trends and prospects of hydropower development and utilization in Africa
6. Major constraints to hydropower utilization in Africa:

   (a) Institutional, juridical and political aspects at the national, subregional and regional levels,

   (b) Transfer of technology

   (c) Education and training

   (d) Flow of information

   (e) Financing

(f) Industrial aspects

(g) Other constraints

7. Discussion on ways and means to overcome exosting constraints in hydropower utilization in Africa at the national, subregional, regional and global levels

8. Formulation of a common hydropower utilization policy for African countries within the framework of the United Nations Conference on New and Renewable Sources of Energy to be held at Nairobi in August 1981

9. Consideration and adoption of the recommendations of the Panel

10. Other matters

11. Consideration and adoption of the report of the Panel

12. Closure of the Panel

Part two:

Role of hydropower within the context of the energy crisis (agenda item 4)

6. Under item 4, the experts first listened to a statement by a member of the secretariat.

7. In a brief historical introduction, he pointed out that man had for a very long time known how to harness hydropower through the use of mechanical devices for grinding cereals and pumping water as well as for operating workshops and factories. However, with the emergence of electricity towards the end of the nineteenth century and later of alternating current technology, the transmission of electricity over long distances had become possible and the harnessing of the motive power of water to generate electricity had made a significant breakthrough that had in large measure contributed to the phasing out of water-mills.

8. Then the merits had been stressed of hydropower. It was a non-polluting source of energy producing neither smoke nor smell, noise nor waste. It was permanently renewable through the action of the sun's energy which generated and maintained the water cycle. In the face of constant increases in the price of fossil fuels and by-products and the foreseeable advent of a widespread energy crisis, hydropower installations could, by providing a constant supply of local energy, make a lasting contribution to reducing substantially the outflow of foreign exchange that could be used in other sectors for the general economic development of a country. Apart from generating electricity, hydro-electric installations could provide such multiple services as irrigation to transform agricultural life, control of waterways to improve navigability and raise the potential of the transport network, flood control and fish breeding. Finally, while it cost more to generate a kilowatt of hydroelectricity than to generate a kilowatt of thermal electricity, hydroelectric power stations were conversely less expensive to thermal power stations and the price per kilowatt/hour generated was less influenced by the economic situation.

9. The importance of hydroelectric installations in the economic development of African countries was also stressed as hydropower possessed obvious advantages in terms of future energy supplies in Africa.

10. For a continent with a large number of land-locked countries (14 out of the 28 in the world) and of countries classified among the world's least developed (20 out of the 30 at that time) which was seriously affected by drought and desertification, hydropower could become a catalyst in the economic development of other resources and in improving living conditions.

11. The construction of hydroelectric stations required considerable manpower and in most cases the establishment of new infrastructre to reach the dam site. It could therefore be effective in combatting unemployment and in improving the living conditions of the inhabitants of an entire region.

12. By making national cadres at all levels aware of techniques and problems in such diverse areas as planning, design, construction, maintenance and management of water projects, building hydro-electric stations played an important role in developing human technical resources whose need was so sorely felt in Africa.

13. The construction of hydro-electric stations was almost always accompanied by the local and even subregional development of the building materials industry, in particular cement, and therefore by greater development of existing natural resources.

14. The value of the hydropower generated as part of a project to develop a river basin could often be the economic factor which enabled the project even a project covering all other long-term water need to be carried out. And yet hydraulic development with a view to maximizing short-term economic returns generally proved to be a serious mistake in the long run. Consequently for the implementation of the Lagos Plan of Action, making best use of water resources would henceforth have to be considered absolutely essential.

15. During the ensuing discussion, the experts described the activities carried out in their respective countries, which varied according to each country's natural, geographical, climatic and other characteristics. They generally agreed, however, that hydroelectric stations should be accorded priority in Africa because of the technically exploitable potential resources of the continent (more than one third of world resources according to various sources) which had scarcely been tapped and because of the numerous services such stations could render.

16. One of the experts' foremost concerns was to improve the lot of the majority of the people, in particular by building micropower stations which could provide electricity to small rural or agro-industrial centres by exploiting low falls.

17. Those people, who frequently lived close to large hydroelectric installations or along the path of transmission lines transporting the energy produced by hydraulic power stations, generally did not enjoy the advantages of electricity because they were not taken into consideration during the project's design stage.

18. It was also noted that there were several small independent grids in Africa supplied by small Diesel generating sets. The disadvantages of such Diesel units were well-known. Such machines required high quality fuel whose price, which was already high was often increased by considerable transport costs. It was also noted that after running the motors at no load or low load for a long time, the over-all thermal effciency of the plants was not very high. The motors operating at high rotational speeds, 1,000 or 1,500 rev/min, had high maintenance costs, long outage periods and a relatively short life span. They sometimes required numerious qualified operators and maintenance personnel.

19. The major advantages of hydro-electric equipment were well-known: no fuel expenditure, generally simple, strong and dependable production groups, which were easy to run required few operators and had low maintenance costs. Finally, the use of water resources to produce hydropower was now a reliable and proved technology. Throughout the world and in Africa there were hydro-power stations of all sizes, ranging from a few dosen to hundreds of kilowatts which had been functioning for years without serious breakdowns and with efficiency rates of about 95 per cent.

20. In that regard, the experts attached great importance to estimates of energy transmission from hydroelectric power stations. For plants with medium and large capacities, energy could be transmitted only via high and very high voltage lines whose costs per kilometre were known to be very high. For the power stations with low capacities energy could be transmitted via medium voltage lines as the centres of consumption were not very distant. The discussion led to the following conclusions: transmitting hydro-electricity from the power station to the centres of consumption was technically and economically feasible over long distances (over 500 km) for medium or large capacity hydro stations. Those conclusions were also valid for small installations using less sophisticated technology when they were located in isolated areas, given the high price of diesel thermal electricity and the difficulties in supplying those areas with petroleum products.

21. Mention was also made of other specific roles of hydropower in Africa since the energy crisis.

22. African hydroelectric potential was very poorly distributed. Some countries had a very limited amount of exploitable hydroelectric resources while their neighbours were blessed with a large hydroelectric potential often exceeding their own needs. Interconnecting neighbouring national electric grids to meet the needs of the countries with few energy resources would give a higher rate of return from the installations such better use would be made of them.

23. It was also noted that funding agencies generally required an economic justification for hydroelectric projects. One way of solving that difficulty might be to meeting the needs of industries manufacturing a number of products and requiring large amounts of electricity. In that stage hydropower acted as a factor of development. In many cases, such as on the Sanage, Zaire, Cuenza, Konkoure, Kouilou and Zambeze rivers, hydropower was one of the best sources for developing industries based on existing mineral deposits.

24. In conclusion the experts expressed the view that African States should develop their hydroelectric potential much more rapidly in order to supply electricity. The choice of hydroelectricity also was of obvious strategic importance for their development: it contributed appreciably to the countries' energy self-sufficiency, improved food security significantly and a large scale irrigation would be made possible by the building of dams and improved the long-term balance of payments as costs were much lower that those of petroleum products which would have to be imported if there were no hydro-electric dams. Such strategic importance in itself could justify investments which would not be immediately profitable from a conventional point of view. That strategy should be implemented promptly since it was necessary each year to install additional production capacity by building thermal power stations to respond immediately to increased electricity demand. Moreover, building thermal power stations, which were more costly, was almost a complete waste since they would automatically be made marginal once hydroelectric facilities had become operational.

25. In addition to the development of their national hydroelectric resources, African countries would be wise to promote subregional co-operation in the exchange of electricity. An interconnected grid would provide significant advantages to all countries concerned:

(a) Rational development of hydroelectric dams,

(b) Reduction of the needed installed production capacity (since the supply system was more flexible, fewer production reserves were necessary),

(c) More reliable supply,

(d) Better utilization of water resources (since the water level of waterways varied from one region to another, dams could, through transport lines, supply each other with water in cases of shortages).

The resultant savings would cover a large share of the costs of developing that network.

Situation, trends and prospects of hydropower development and utilization in Africa (agenda item 5)

26. For consideration of item 5, the experts had before them a study prepared by the secretariat which first of all presented a table outlining in as detailed

a fashion as possible the current over-all situation of the development and utilization of hydropower and then shed light on some major trends and prospects.

27. The document indicated that the hydroelectric resources of the continent had been only partly explored to date and were still poorly known. Estimates of the resources were uncertain, on the one hand because of a lack of hydrological data for most waterways and, on the other, the inadequacy of studies on projects for the development of a number of possible sites. That situation was also probably the result of the high costs and long period of time required to do research in order to draw up a real inventory of hydraulic resources providing a better understanding of a country's hydroelectric potential. Likewise studies done until then had, in most cases, a specific goal: to supply urban centres and mining or industrial installations. The characteristics of the demand limited research from the point of view both of the capacity to be installed and the geographical area to be explored.

28. Notwithstanding the incomplete and inaccurate inventory, the hydroelectric potential of Africa seemed to represent a major portion of world resources: according to various sources it would constitute more than a third of the technically exploitable world hydroelectric potential.

29. Another characteristic of African hydroelectric potential was its poor distribution. On the basis of the subregional divisions used the United Nations Economic Commission for Africa, the Central African subregion accounted for 46 per cent of the continent's hydroelectric potential, as against roughly 27 per cent for Southern Africa, 10 per cent for West Africa 5 per cent for North Africa and 12 per cent for Eastern Africa.

30. The subregional distribution of hydropower resources itself concealed great differences in the hydroelectric potential of the African countries. Some countries such as Benin, Togo, Mauritania, the Libyan Arab Jamahiriya and Somalia had relatively few exploitable hydroelectric resources, while others, such as Zaire, Angola, Madagascar and the United Republic of Cameroon, to name only a few, possessed them in great quantity.

31. Many African countries were interested in developing their sites. Thus, while only 18 African countries had produced electric energy from hydropower in 1957, there had been 31 in 1967 and 34 in 1978. The last figure included eight countries that met over 90 per cent of their needs in electricity with hydropower and nine others that met between 50 and 90 per cent in that way.

32. In 1978 10 principal hydroelectric energy-producing countries in Africa alone had supplied nearly 98 per cent of the continent's hydropower energy.

33. Hydroelectricity accounted for approximately 32 per cent of all electricity produced in Africa. At the end of 1978 total electricity production had reached only 9.5 per cent of the continent's over-all hydroelectric potential. Hydroelectric production represented a minute part of that potential, only 3 per cent. Total thermal and hydroelectric installed capacity was in the

neighbourhood of 18 per cent of Africa's hydroelectric potential while hydroelectric installed capacity represented barely 6 per cent of that capacity. Thus, in spite of its enormous hydropower potential, Africa was still underequipped in the area of hydroelectric plants.

34. The aforegoing observations were generally true for most States that were considered to be particularly rich in water resources even though in places, remarkable progress had already been made and several new hydroelectric stations were being constructed or were under study, as the various papers submitted by experts on their country situations continued.

35. In the United Republic of Cameroon, where the hydroelectricity potential was estimated at over 150 billion kWh/year, an exhaustive inventory was being conducted on coastal as well as inland rivers to identify sites that could produce more than one million kWh/year. Less than one per cent of that potential was now being exploited. Current installed capacity, which stood at around 270 MW out of a possible 1.3 billion kWh per year, would be increased to 490 MW out of a possible 2.5 billion kWh per year by 1983. In Gabon, the most promising sites on major waterways had been explored and would yield a guaranteed total of over 40 billion kWh of which less than one per cent was being exploited. In Ethiopia, out of a potential 60 billion kWh/year, the production capacity of existing plants was 1.044 billion kWh or 1.74 per cent. In the Sudan, the production capacity of on-stream plants was 5 per cent of the country's hydroelectric potential. In Guinea, the only site to have been developed was the 20-MW Grandes Chutes Plant with a production capacity of 45 million kWh, whereas the hydroelectric potential of the country was estimated at over 26 billion kWh per year. Two significant structures were to be built on the Konkoure, one at Souapiti (750MW) and the other at Amaria (450 MW). In the United Republic of Tanzania total hydroelectric potential was estimated at around 3,000 MW but a large proportion of that amount was not exploited since total hydroelectric capacity was 246 MW or 8 per cent of the potential. In Zambia where the potential was estimated at 4.60 GW, the total power of the hydro stations in operation was 1.62 GW or 35 per cent of the potential.

36. The above-mentioned points led the experts to set the following priorities for African countries:

(i) the formulation of real short-, medium- and long-term national energy policies,

(ii) the stepping up of exploration with a view to drawing up a comprehensive inventory of the potential and development and utilization prospects of energy resources and the equipment required,

(iii) the organization of joint operations in two or more African countries for the development and use of existing energy resources.

37. Examples of countries that had already begun to compile inventories of their water resources taking various possible uses into account were cited. Similarly, it was observed that planners were becoming increasingly interested in the establishment of small hydroelectric power stations in rural areas.

38. Since 1973, co-operation in energy had been reinforced in various parts of Africa.

39. In West Africa for example, Mali, Mauritania and Senegal, as members of the Organization for the Development of the Senegal River (OMVS), had begun to implement a large-scale programme for the integrated development of that river basin. Senegal and the Gambia, to be joined eventually by Guinea, had set up an organization similar to OMVS for the use of the Gambia River. Liberia, together with its neighbours Sierra Leone and the Ivory Coast, was actively seeking to exploit the Mano and Cavally Rivers. Studies on the interconnexion of Ghana's grid with that of the Ivory Coast had already been completed. Ghana, the Upper Volta and the Ivory Coast were negotiating an agreement for the joint hydro-electrical development of Bui. Togo and Benin obtained most of their electricity from the hydro-electric power station at Akossombo in Ghana. The Communaute electrique du Benin the entity with a monopoly on electricity production in Benin and Togo had held talks with Nigeria to obtain electrical energy for those two countries from Nigerian hydro-electric power sources. The capital of the Niger would henceforth receive its electricity from Kainji, Nigeria's principal hydro-electric power station. Finally, in the West African subregion, the Liptako-Gourma Region Integrated Development Authority, which had as its members the Upper Volta, Mali, and the Niger, had undertaken a study of four sites favourable to the production of electrical energy.

40. In the Central African subregion energy exchanges currently existed only between the Congo and Zaire.

41. In East and Southern Africa the major hydroelectric power stations at Cabora Bassa and Cunene provided power to South Africa and to much of Namibia respectively. Links also existed between Zambia and its neighbours, Zaire and Zimbabwe on the one hand and Kenya and Uganda on the other. In the same manner, Lesotho and Swaziland were partially dependent on South Africa for electricity. Electricity for the capital of Burundi was provided by the Mururu hydro-electric power station near Bukavu in Zaire.

42. In North Africa, a few links had been established between Algeria and its Maghreb neighbours, Tunisia and Morocco. No large-scale transmission took place over those links, and all exchanges between Algeria and Morocco had stopped since 1972. A permanent technical commission for the Nile operated between the Sudan and Egypt.

43. Favourable prospects for co-operation in energy within the different subregions were beginning to appear in Africa. The strengthening of

activities of such organizations as the Inter-African Committee for Hydraulic Studies, the River Niger Commission and the Lake Chad Basin Commission could only contribute to the harmonization of study programmes of general interest, thus facilitating the exchange of information necessary to the development of basic plans for the various African river basins.

Major constraints to hydropower utilization in Africa - Discussion on ways and means to overcome them at all levels (agenda items 6 and 7)

44. The experts decided to consolidate agenda items 6 and 7 in order to determine what solutions they should recommend for each major constraint identified.

(a) Institutional, juridical and political aspects

45. The experts noted that at the national level, responsibility for conducting studies on building and managing hydro-electric plants was shared by several administrative departments simultaneously, whereas such operations required a far more global approach. Such an approach implied that permanent technical and political structures empowered to deal with all energy problems needed to be established. Since water resources development and utilization problems were varied and connected with the operations of such ministries as agriculture, industry, tourism, equipment and energy, it was unthinkable that a coherent policy could be formulated and implemented without its being co-ordinated at a very high level by a single authority.

46. Rivers in Africa often constituted common borders or crossed several borders in succession. To evaluate any hydro-electric development project of whatever magnitude, all long-term hydraulic needs and the means of meeting them had to be taken into account. It was therefore indispensable to establish a global project for the over-all hydro-electric development of a river basin. Frequently, such a project had also to consider the hydrographic needs of adjacent river basins. In fact, the co-operation among the countries concerned was the basic problem encountered in the development of African river basins. For that reason in those cases the conclusion of bilateral or multilateral treaties was essential.

47. In certain cases there was no legislation on water resources that could be used to arbitrate between various users at the national, subregional and regional levels. The lack of such legislation and regulations often led to conflicts.

48. Political considerations could greatly influence the design of projects. Many African countries felt that they relinquished their sovereignty when they depended on their neighbours for energy supplies. That led either to cautious commitment or to dramatic reversals of policy. The experts also deplored the reluctance of some States to modify their development plans to take into account of the different aspirations of their neighbours with limited water resources. In such cases one party might be interested in the electricity generation while another was interested principally in irrigation and water supply. There was also the fact that the financing of dam projects required a massive amount of foreign aid, necessarily with political implications. The experts therefore

strongly recommended that Africa should demonstrate sufficient political will to promote genuine co-operation and active solidarity for hydropower development and utilization.

(b) Transfer of technology

49. The experts realized that African countries were compelled to embark on years of endless study before they could justify, in terms of the criteria of funding agencies, the economic viability of their development projects. Development assistance agencies therefore tended to contribute to the operating accounts of their countries' consultancy firms by supplying them with work of doubtful utility. That explained in part why many studies were never translated into reality.

Such an approach impeded the establishment at the national, subregional and regional levels of authentic consultancy firms that were a prerequisite for preparing projects that actually reflected the aspirations and needs of the local environment.

50. The African experts deplored the complex that many decision-makers still had about foreign expertise. Africans needed to have confidence in themselves since experience had proved that work entrusted to foreign experts was not free from flaws and disappointing failure.

51. Co-operation between funding agencies and foreign construction companies was difficult to secure in order to implement small projects often in rural areas where most of the population lived. The African experts recommended that the establishment of genuine African consultancy firms at the national, subregional and regional levels should be encouraged, and that those firms should be given design studies for small installations as a matter of priority, whenever possible. They recommended that the water and energy sections of ECA and other co-operation institutions such as CIEH, the River Niger Commission, etc., should be strengthened with teams of African experts who could assist States in conducting such projects.

52. At times the lack of electrical standardization hindered exchanges between African technicians inappropriate application of European standards slowed the development of African industries. In order to leave the past, in which colonialism determined everything, behind the African experts felt it essential that the African Regional Organization for Standardization should be supported in its efforts at all levels and provided with effective resources for achieving its goals.

(c) Education and training

53. Having acknowledged that many African States remained overly dependent on foreign technical manpower, the African experts felt it essential that special attention should be given to the establishment of local training resources.

54. Training centres for technicians at all levels existed within the subregions. It would be particularly desirable first of all to make such infrastructures available to neighbouring States and subsequently to strengthen them so that they might meet all the needs of the subregions' technicians. The example of the Intra-African Advanced Electricity School established by the Union of Producers Conveyors and Distributions of Electric Energy in Africa (UPDEA) should be emulated.

(d) Information

55. Technicians were frequently uninformed about the progress made in their professional fields except by publications and journals coming from the former colonial powers. Often successes achieved in Third World countries or in Africa itself were entirely ignored, even though those countries needed to promote the simplest, most unsophisticated technologies in order to meet the needs of the rural population. Accordingly, the African experts recommended the establishment in Africa of a documentation centre responsible for collecting, disseminating and storing information.

56. The fact that for a long time Africa had had no framework for co-operation, the exchange of information and ideas had often hampered the efforts of its government experts. That was why the experts noted with satisfaction that non-governmental organizations were being established with the aim inter-alia, of providing a forum for African experts to discuss problems of mutual interest. The current edition of the Annual Conference of Eastern and Central African Electricity Corporations towards a structure similar to that of the Union of Producers, Conveyors and Distributors of Electric Energy needed to be encouraged and assistance for the starting period secured from the United Nations Economic Commission for Africa.

57. The Panel realized that there were no basic data to provide a better picture of Africa's waterways and lakes and, after a lengthy discussion of ways and means of overcoming that constraint, recommended that data banks should be established at the level of such bodies as the River Niger Commission, the Lake Chad Basin Commission, the Organisation for the Development of the Senegal River (OMVS) and CIEH by providing them with human and financial resources and with all the information gathered by United Nations programmes on world hydrology or by public or private agencies of former colonial Powers. Similar organizations needed to be promoted in respect of basins for which no such institutions existed.

(e) Financing

58. The question of financing was crucial to any hydroelectric project and Africa's lack of funds was well known: foreign financial investment was the only recourse.

59. However, the experts deplored the little interest that funding agencies attached to small projects. Their tender procedures were often cumbersome and ineffective. Their frequent concern about subdividing the contract into different parts in order to be able to identifying where their contribution lay was disturbing to countries seeking financing. The practice of tied aid or of

supplies credit strongly limited access to international competition to lower investment costs. The frequent reluctance to participate in the financing of basic infrastructures, without which the project would be difficult to implement (feeder roads, residences, improved means of transport, bridges, telephones, etc.) slowed down the implementation of projects. The systematic use of consultance firms or construction companies of developed countries seriously hampered African countries and prevented the establishment of a supply of local technically trained manpower. The evaluation criteria for projects often did not take into account the socio-economic considerations of African countries, especially since the reliability of the criteria used as the population statistics often left much to be desired.

60. African countries should be tenacious in combatting all such practices. In particular, they should defend their national right to implement small projects and do their utmost to obtain competitive conditions when it was not possible to use African skills.

61. It was highly recommended that the electricity rates applied should be such that electricity companies would have sufficient resources to ensure an adequate amount of self-financing.

62. Special efforts should also be made by African financing agencies to develop the continent's hydroelectric resources. In addition, aid funds and international and governmental financing agencies should make a greater contribution.

(f) Industrial aspects

63. There was at present no large scale enterprise in Africa manufacturing equipment for hydroelectric plants and electricity transmission and distribution networks. Moreover because of the varied specifications of the equipment, the market was not sufficiently large even at the regional level. For a long time to come Africa would depend on the outside world in that regard although it had considerable mineral and energy resources. The experts therefore felt that it was essential that such industries should rapidly be promoted by encouraging highly any initiative which might be made. Moreover, agencies should be established at the subregional and regional levels to help to standardize the specifications of equipment and thus encourage the manufacture of material that was better adapted to the needs of African countries.

(g) Other constraints

64. It was essential in any project to consider the impact of hydroelectric development on the environment. Particular attention should be given to problems of health and displaced persons as a result of the flooding of villages and fields to construct the artificial lake.

65. African countries must draw up a true energy policy and possess a master plan on the subject. Every effort must be made to integrate energy activities in over-all national economic and development planning.

Formulation of a common hydropower utilization policy for African countries within the framework of the United Nations Conference on New and Renewable Sources of Energy to be held at Nairobi in August 1981 (agenda item 8)

66. Under agenda item 8, experts were informed of the important decisions adopted at the first economic summit of the Assembly of Heads of State and Government of the Organization of African Unity held at Lagos (Nigeria) on 28 and 29 April 1980.

67. For the medium- and long-term development of hydroelectric resources, the Lagos Plan of Action recommended:

"Development of hydropower resources

- inventory of hydropower resources in all African countries taking into account their integrated utilization such as electricity production, irrigation, fisheries, navigation, etc.,

- surveys of hydroelectric power plants and master plans at the scale of whole river basins for an optimum exploitation of the resources, which should include rural electrification,

- development of economically attractive small-scale hydroelectric power schemes for rural areas,

- need for neighbouring countries to exploit hydroelectric installations jointly. In that connexion, certain commonly neglected parameters should be taken into account such as the need to protect the environment, health problems and the relocation of the people who had had to be moved,

- evaluation of the needs to be satisfied since the investment required is large. As far as the conveyance of energy over long distances was concerned, the advantages of direct current should be considered in the future,

- study on internationalizing the status of installations from the point of view of ensuring safe supplies of electrical energy,

- when finance was being sought, projects should be given a subregional and possible regional character so as to make better use of the priority often given to undertakings of that type,

- in the search for solutions to the energy problem, priority should be given to sites with great hydropotential, since their enormous potential would make it possible to consider interconnecting a large number of African countries,

- establishment of national boards for rural electrification,

- promotion of standardization in power supply equipment and expansion of interconnexion of grids (including a decrease in number of existing voltage levels),

- manufacture of electrical equipment suitable to the needs of African countries by utilizing local raw materials".

68. After an exchange of views on what might constitute a common African position for the United Nations Conference on New and Renewable Sources of Energy, the experts decided that they would annex to the report of their panel meeting recommendations for submission to the intergovernmental meeting to be held from 12 to 16 January 1981 in Addis Ababa, Ethiopia.

Consideration and adoption of the recommendations of the Panel (agenda item 9)

69. The Rapporteur introduced a set of draft recommendations which had been formulated at the end of the deliberations. After they had been considered and amended, they were adopted and are contained in the third part of the present report.

Other matters (agenda item 10)

70. No other matters were raised under this agenda item.

Consideration and adoption of the report of the Panel (agenda item 11)

71. After the present final report had been considered and amended, it was adopted on Friday, 24 October 1980.

Closure of the Panel (agenda item 12)

72. Following the adoption of the report and recommendations, the Chairman declared the Panel closed. The Acting Chief of the Division of Natural Resources and the Chief of the Energy Unit then held a brief ceremony to congratulate the experts on their important contribution to the preparations for the United Nations Conference on New and Renewable Sources of Energy.

Part three

RECOMMENDATIONS

73. The Technical Panel of Experts on Hydropower, aware of the major role to be played by hydropower in Africa in solving energy problems because of the continent's significant hydroelectric potential, recommends that special attention should be given to the development of these resources.

To this end, plans of action at the national, subregional and regional levels should be drawn up relating to planning, the construction of installations and intra-African co-operation.

Planning

74. To carry out the recommended planning, it is essential, on the one hand, to collect all technical data in order to draw up as comprehensive an inventory as possible and, on the other, to prepare national and regional master plans.

75. It will thus be necessary to restructure national planning services and to set up co-ordination machineries and bodies at the subregional and regional levels.

Construction and exploitation

76. As concerns the building of installations, the Panel of Experts recommends the establishment, development and promotion of African consultancy firms, construction enterprises and industries.

77. Particular importance should be attached to meeting rural needs.

78. The Panel of Experts recommends the formulation and enforcement of standards and general specifications at the national and regional levels.

79. Large numbers of skilled personnel will be essential. Training institutions should therefore be established or strengthened.

80. Adequate measures should be taken to facilitate the free movement of skilled manpower among African countries.

81. Various national and regional bodies responsible for the development and exploitation of water resources should organize or intensify exchanges of information and experience.

82. With regard to project funding, whenever possible national or regional contributions should be sought first. When external funds are used, they should be obtained under the most favourable conditions possible.

Conventions and institutions

83. Legislation and regulations relating to national, subregional and regional plans should be drafted in order to make the implementation of all operations possible.

84. The Panel of Experts recommends the development of legal and institutional co-operation structures at all levels in order to promote the establishment and functioning of African co-operation bodies. In this respect, special attention should be given to the establishment of the African Energy Commission, as recommended by the Lagos Plan of Action. It will also be necessary to prepare model conventions and treaties.

85. Existing technical and economic documentation centres should be strengthened and a data bank set up to compete all information thus facilitating its storage and broad dissemination.

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